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THE PRODUCTION OF WOOD CHIPS FOR COARSE FIBER IN THE CENTRAL STATES REGION

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by

James T. Morgan

INTRODUCTION

Every farmer who is interested in making the most from his woodlot probably has said to himself, "I know there are trees on my land that aren't doing me or the woods any good, but how can I afford to take them out?" Many loggers have looked over acres of heavy slash left after hardwood logging, wishing it were possible to market the whole tree, not just the straight, clear portion of the trunk. Sawmill operators and other manufacturers, large and small, are obliged to dispose of slabs, edgings, sawdust, and shavings, which amount to a large percentage of the total volume of the wood they buy. The volume of unused material is tremendous. The obstacles that stand in the way of fuller utilization deserve close scrutiny.

Cull and waste wood in the Central Hardwood region can be used to produce fiber for certain classes of paper and board. However, the traditional pulp and paper industries have used very little of this wood waste because better quality wood has usually cost less. Harvesting, collecting, handling, and barking costs are higher for cull trees and logging slash than for straight, clear growing stock. Barking costs have hindered the use of slabwood. Wood buyers naturally have taken the material that offered the lowest total cost, not that which could best be spared. Consequently, while good growing stock is cut into pulpwood, the waste problem is still with us.

In recent years, however, the manufacturers of wallboard, container board, insulation, felt, and building paper have provided an opportunity to use some of this waste. These products were formerly made from rags, wood pulp, and waste paper. More recently, coarse wood fiber has been substituted for rags and wood pulp. Coarse wood fiber is composed largely of fiber bundles rather than individual fibers, and may contain some bark. Manufacturers of the above products are expanding plant capacity and are searching for new sources of raw material. The availability and costs of lower-quality wood are therefore becoming important to both buyers and sellers, especially in this region where the greater part of all wood used is imported. Because of this shift in raw materials, industry operators want to know the relative costs of wood from several sources that up to now have received scant attention. Likewise, woods operators see the possibility of new markets for low-grade material, if collecting and processing

costs are low enough to permit an operating profit. The objective of this publication is to furnish basic information on the problems and costs of procuring and chipping wood for coarse fiber in the Central States region, and to examine the possibilities for greater use of several kinds of low-quality and waste wood.

Information for this paper was gathered in 1947-48, largely by observing the procuring and handling of wood by the felt mills of the asphalt roofing industry in the Central States region. These mills are at present the principal users of rough wood chips in this region. They use, in varying quantities, wood from almost every source including sawmills, veneer mills, and remanufacturing plants, as well as roundwood from the forest. They are probably the forerunners of other industries that will employ mechanical and semichemical methods to make coarse fibers and pulps. As such, they offer an opportunity to study the problems involved in concentrating and utilizing the available wood resources. Some of the factors that determine the felt makers' choice of wood may apply as well to the future manufacture of such fibrous products as hardboard and corrugating board and to such nonfibrous products as wood yeast and molasses.

In the course of the study, all of the felt mills that use coarse wood fiber were visited to learn manufacturers' preferences and specifications for wood, and to observe handling procedures. Wood suppliers such as sawmills, woodworking plants, and waste dealers were visited to obtain information on costs and methods of processing waste wood suitable for conversion to coarse fiber. Finally, woods operations, where green wood was cut for felt making, were studied. In the latter case, an effort was made to secure reliable production data for men working in different kinds of timber stands and using various kinds of equipment.

Because the extreme variability of operating procedures and equipment made intensive study impractical, so-called "stop watch" records were not kept. Costs in terms of man- and equipment-hours were collected on different operations and compared. These figures were derived from (a) personal observations, sometimes extending over a several-day period; (b) interviews with individual workers to get for the previous few days their production and hours worked; (c) verification of information obtained under item (b) from the truck drivers hauling wood; (d) book records of cordwood purchasers; and (e) in the case of manufacturing waste, observations at plants and records of operators. From these figures, averages were drawn to show the range of costs that might be expected under certain conditions.

ROOFING FELT, A NEW USE FOR COARSE WOOD FIBER

Roofing felt is a soft, very absorbent, rough paper. When saturated with hot asphalt, coated with asphalt and mineral granules, and cut into strips or shingles, it becomes roofing. The plants that make it are essentially small paper mills, where various raw materials

are reduced to fibers or fiber bundles and blended in water to form a fluid pulp. The pulp is felted, drained, and dried on paper machines.

The roofing felt industry began to use wood just prior to World War II. During the war, rags became scarce and costly while demand for roofing zoomed--as a result, more and more wood was used. Today asphalt roofing does not yet rank as a large wood-using industry. Still, 1948 wood consumption by this industry in the states of Illinois, Indiana, and Ohio was estimated to be more than 200,000 tons. This wood arrived at felt mills in the forms and approximate quantities (thousand short tons) shown below:

	Chips 1/	Whole wood fiber 2/	Wood flour 3/	Dry blockwood and shavings 3/
Central hardwoods	125			
Northern hardwoods & hemlock	55	8		
Pine	4		12.5	4
Total	184	8	12.5	4

Chips of central hardwoods are made entirely from "feltwood," that is, green cordwood cut especially for the purpose. Northern hardwood and hemlock chips come from Lake States' sawmill and veneer mill waste. Whole wood fiber mechanically shredded from aspen bolts is likewise shipped in from the North. Most of the wood flour, used by mills whose product has a high rag content, is produced by grinding softwood waste from remanufacturing plants, which also furnish dry blockwood and shavings.

Wood, rags, and waste paper are the principal raw materials now used in felt making. To some extent wood and rags are interchangeable. Mills that have chip-fiberizing equipment use up to 50 percent wood fiber; mills without such equipment use rags or in some cases purchased wood fiber. The trend is toward a greater use of wood, as more fiberizing machinery is installed. Waste paper constitutes 40 to 90 percent of the total raw material, depending on the type of felt desired. Other materials sometimes added in small quantities are sugarcane residue (bagasse), jute, tow, wool, cotton, waste felt, and coarse wood flour. The costs and prices of chips and wood flour from various sources, mostly within this region, will be discussed throughout the paper. Recent prices of important competitive or supplementary fiber materials have been: whole wood fiber (shredded aspen) $15 to $16, waste paper $12 to $15, and roofing rags $25 to $40 per ton.4/

1/ Moisture content 40 to 45 percent of total weight.
2/ Moisture content about 40 percent of total weight.
3/ Moisture content about 7 percent of total weight.
4/ Unless otherwise noted, all price, wage, and cost figures in this paper apply to the years 1947-48.

Cordwood and chip specifications and preferences are not standard; they vary from plant to plant. There are, however, some general areas of agreement, and the reasons for the common preferences have a bearing on the utility of wood for other products. For instance, mill operators prefer to receive wood in green condition. Green wood is chipped faster and cheaper than partially dried wood. Chips from green wood are more uniform in size, and when fiberized, give a more uniform pulp at a lower cost.

Each plant's specifications exclude some species of wood. Some plants use all but the hardest of local woods, such as osage-orange and black locust. Some accept only soft bottomland hardwoods such as cottonwood, willow, and soft maple. Finally, some mix hardwood chips with coniferous chips, which are highly preferred but difficult to obtain within reasonable distances. In general, soft-textured woods are less expensive to process, and result in a more absorbent and flexible sheet. There are, however, indications that the harder woods may increase the durability of the product. Rotten wood has little fiber strength and is not accepted in large quantities although small percentages are sometimes overlooked. Bark is of unknown but doubtful value. Many mills use unpeeled cordwood of both thick-barked and thin-barked species, but none of them use chips made entirely from the slabs and edgings of central hardwood logs, which normally contain high percentages of bark.

The maximum diameter of bolts acceptable to any plant is determined by the design of the chipper used. Chippers that will handle roundwood up to 10 or 12 inches in diameter are common, but some smaller machines, admitting wood up to 8 inches only, are also used. Bolts are normally 4 to 8 feet long. Wood is frequently purchased by the ton rather than by the cord, thus eliminating the necessity of cutting to exact length.

ROUNDWOOD FROM THE FOREST

Because green cordwood can be chipped and fiberized easily, it is the major source of wood for coarse fiber in the Central States region. If chips from low-quality and waste material are to supply this market, they must not only be acceptable for the intended product, they must be cheaper than other chips. Thus, the costs of cordwood chip production are important to the potential sellers of low-quality wood, as well as to the buyers of chips.

Most of the cordwood comes from land clearing by farmers, small-scale loggers, and professional woodcutters. In recent years high prices for agricultural products have stimulated the clearing of forested land. Riverbottom tracts that are periodically covered by flood waters are being cleared for crop planting (fig. 1). Under the impetus of high returns from livestock production, upland woodlots are being converted to natural and seeded pastures. Timber on such areas is sold at a low price or given away. Some landowners simply sell the

timber without having any definite land use in mind. In addition, small quantities of wood come from ordinary logging operations where sawlogs are the main product.

Figure 1.--Riverbottom area being clear-cut. High stumps were left to avoid having to split bolts that were too large for the chipper.

Cordwood is not at present expensive. The price varies from about $6.50 to $14.00 per standard cord delivered, depending somewhat on the prevailing local wage scale, the quantity of wood available, and on the weight of wood when purchased by the ton. Except in dense pole stands, the price just about covers the cost of harvesting and hauling with little if any margin for stumpage and profit. Some of the reasons why wood is cut and sold at such prices are:

1. Current demand for new cropland, which encourages timber cutting. Farm real estate prices are near an all-time peak.

2. Failure of landowners to appreciate the potential value of pole-sized timber. Young stands are usually undervalued in comparison with cleared crop or pasture land.

3. Small size of individual ownerships. Many of them are in such small tracts that they cannot be economically managed as separate units.

4. Disinterest of landowners, whose main income is seldom derived from forest land.

5. Presence of woodcutters, or "tie-hackers," who would rather work independently in the woods at relatively low income than work in town or factory for higher wages.

Typical cordwood cutters work individually or in small crews, seldom more than four or five men per cutting area. Generally, there is no supervisor or manager. The wood cut by each man or small crew is piled and hauled separately, and the money received is divided among

the workers in place of wages. Some cutters own trucks and haul their own wood; others pay independent truckers for hauling. Most cutters operate on a slim financial margin and prefer payment when wood is delivered. They seldom work a full 5- or 6-day week. Others are farmers working on their own land, cutting in their spare time.

Cutting done under these conditions is piecemeal and unorganized. More efficient operators are not attracted to the business because of high risk and small profit. Investment in planning, mechanization, and management could increase wood production per man-hour, but because of other factors, the total cost per cord might also increase. Some of these factors are:

1. Fluctuating demand for wood. Mills sometimes require an increased supply at times when weather prevents cutting. Then, just when cutters are producing steadily, mills are sometimes forced to stop wood purchases because of oversupply or plant shutdowns. Stockpiling by the cutter is impractical because of the expense and risk, and, when wood is sold on a weight basis, because of loss of moisture.

2. Scarcity of suitable stumpage. Timber within economical hauling distance of the mills is in small scattered tracts. Nonproductive time spent moving elaborate equipment and men from one location to another increases costs.

3. High labor costs. If an operator hires men to work in the woods, he becomes an employer and incurs costs that the independent cutter does not have. An employer must observe the provisions of the wage and hour law, must pay social security taxes, unemployment compensation, and industrial accident insurance. In the aggregate these may increase his actual payroll by as much as 10 to 15 percent. Wages paid for woods work, like other wages in this region, are relatively high. Productivity of workers, taken on the average, is less at hourly rates than at piecework rates or for individual enterprises.

4. Larger crews required for mechanization. In order to get full value from power saws, skidding equipment, or loaders, they must be in constant use. This requires a sizable crew. Thus a fully mechanized job cannot be a small operation--it must employ enough men to do the manual labor necessary to keep the machines running. This means a large output, which cannot always be readily marketed.

Whatever the reason, most of the attempts to mechanize cordwood cutting in the Central States region have failed. Permanent, well-planned organizations might succeed if the wood market were larger and more stable, but under present conditions most of the cutting will be done more or less at random by part-time, seasonal workers.

Most forest products are sold by some unit of volume, such as board foot or cubic foot, or by the cord or piece. Feltwood, on the contrary, is often sold by the ton. This is logical since the weight of the wood, corrected for moisture content, is an indication of the yield of pulp to be expected. Moreover, selling by weight has other advantages. It eliminates measuring each piece to be cut, careful piling, and scaling of piles. It discourages splitting to small diameters and piling in "loose" cords. It encourages prompt delivery of green wood, which brings the maximum price and is desired by the mill man. It also results in greater production per man-day. Below is a comparison of the production per man-day on two otherwise similar operations in oak logging slash. In one (A) cutters piled the 4-foot wood in standard cords, while in the other (B) cutters cut the wood in variable lengths and laid it in windrows to be loaded and weighed. Axes and crosscut saws were used in both cases.

Operation	Length of bolts	Maximum diameter	Piled	Production per man-day
	Feet	Inches		Tons
A	4	8	yes	1.6
B	6-8	11	no	3.0

The difficulty of estimating weights of wood is a minor disadvantage of the system. Bolts in a truckload may be of several species and may range in diameter from a 2-inch section of a limb to a 12-inch log. In general, weights of feltwood follow the pattern shown below:

	Tons per cord
Mixed bottomland species 5/	
Green (moisture content 40-50 percent of total weight)	2.0
3-months dry (moisture content 20-30 percent of total weight after 3 summer months)	1.4
Mixed upland species 6/	
Green (moisture content 40-50 percent of total weight)	2.5
3-months dry (moisture content 20-30 percent of total weight after 3 summer months)	1.8

These differences in weights are important. Equal tonnages of bottomland and upland species yield similar weights of pulp or fiber, but equal cordwood volumes do not. Men cutting in oak-hickory stands may become discouraged at their low production in cords, while their

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5/ Cottonwood, silver maple, and American elm predominate with willow, sweetgum, sycamore, blackgum, and others present.

6/ Oak and hickory predominate with ash, beech, sugar maple, and others present.

production in tons may be commendable. Lack of knowledge of wood weights has led to consistent overloading of trucks and costly breakdowns. Operators maintaining a large wood inventory without allowance for moisture loss have discovered that they were carrying hundreds of tons on their books that were not in the yard. Weights of species and rates of moisture loss are so variable that the allowance for error should be generous.

PRODUCTION PER MAN-DAY

Below is a tabulation showing the average number of tons of feltwood produced per 8-hour man-day by fair-to-good woodsmen using three types of power saws and hand tools.

	Chain bar saw	Circular saw	Chain bow saw	Hand tools
Clear-cutting pole-sized bottomland timber	7-8	5-6	6-8	4-5
Clear-cutting pole-sized upland timber	5-6	4-5	---	3-4
Cutting bottomland logging slash	---	---	---	4-5
Cutting upland logging slash	4-5	---	---	2-3

These figures cover only two types of cutting--clear-cutting young stands, and working up tops and limbs. These two account for more than 90 percent of the cordwood cut for felt making. A few partial cuttings were visited but did not yield data sufficient to provide reliable production figures.

Clear-cutting with Power Saws

Bottomland stands include the forests that occur in the low, level lands along streams and river margins. These forests yield the fast-growing, soft-textured, easily processed timber that is currently most sought for pulpwood. Pole stands, in which trees 5 to 10 inches in diameter predominate, often contain 60 tons (30 cords) or more per acre.

Clear-cutting with power saws in bottomland pole stands gave the greatest production per man-day and the lowest cost per ton, as was expected. Cutters normally choose these conditions if there is a choice, but their choice is also influenced by such factors as weather and availability of stumpage within hauling distance. Two- and three-man crews using 2-man chain bar saws cut as much as 8 tons per man-day, the 3-man crews having a greater advantage. Two-man

crews using wheel-mounted circular saws averaged 5 to 6 tons per man-day in these stands. One man with a chain bow saw could fall and buck 6 to 8 tons a day under favorable conditions. All of these figures apply to heavily stocked stands (60 tons or more per acre) of trees 60 feet or more in height. Production is less in poorly stocked stands. However, many bottomland stands, regenerating naturally after previous clear-cuttings, are well stocked.

Upland stands contain such woodlot hardwoods as red and white oaks, various hickories, ash, and sugar maple. The original old-growth forests have been heavily cut, occasionally burned, and frequently pastured. Thus the residual stands often consist of poorly formed and defective trees that are usually shorter and more limby than trees in the riverbottom forests. Young, even-aged, upland stands as a rule have less clear stem length and less volume per acre than bottomland stands of the same age. Upland species are slower growing. They produce wood that is heavier and more difficult to chop or saw.

Upland pole stands are not so favorable for cutting. The advantage of heavier wood, when sold by the ton, does not compensate for the disadvantages mentioned above. Three-man chain saw crews averaged 5 to 6 tons of wood per man-day when clear-cutting mixed upland hardwoods. One man with a circular power saw cut 4 to 5 tons a day in a thick stand of pole-sized hickory (fig. 2). Average production in the better upland stands was 1 or more tons per man-day less than the production of the same crews in the better bottomland stands.

Figure 2.--Farmer clear-cutting upland pole stand with a circular power saw.

In none of the observed operations was the power saw actually used more than 3 1/2 hours a day. The cutters spent the remainder of each day limbing, splitting bolts, and loading trucks. This part-time use of power equipment is one of the principal inefficiencies of power-saw operation with small crews. During the time the saw is idle the skilled sawyers do work that could be assigned to common labor. With proper organization, the rate of production could be increased considerably.

A study of pulpwood production in southern pine[7/] showed a 3-man chain-saw crew to be much more efficient than a 4-man crew. Observations of feltwood cuttings in the Central States hardwoods indicate that, because the greater volume in tops and limbs requires more trimming, prying, and brush piling, the power-saw crew should be at least four men and in some cases five men per saw.

Circular saws are difficult to operate on hilly or wet sites, especially where undergrowth is thick. They can seldom be used for limbing. In this region they are used to best advantage as bucking saws at a central point. Since the price of feltwood is seldom enough to cover skidding, only those areas into which trucks can be driven are cut. Consequently, circular saws find less use than chain saws because the latter are more maneuverable. The chain bow saw, because it is light in weight and does not "pinch" in the log, is a promising development in hardwood pulpwood cutting. One-man chain bar saws also are coming into greater use, but too few operations were observed to yield representative production figures.

Clear-cutting with Hand Tools

Clear-cutting with axe and crosscut or bow saw, the conventional hand tools, is still the most prevalent method of cutting feltwood. Under certain conditions, the cutters working with hand tools earn more than those working with power saws, but ordinarily the reverse is true. Hand tools are used to better advantage where trees are scattered and limby, or where heavy underbrush prevents easy movement of the power saw.

In thick pole stands of cottonwood and soft maple, axmen and sawyers can cut on the average 4 to 5 tons of wood per man-day. Individuals may cut as much as a ton an hour but not consistently. Tree height and clear length as well as number of stems per acre influence production. Axmen in a stand of even-aged willow that averaged 40 tons per acre cut only 3 to 4 tons a day. The trees in this stand were about 45 feet in total height, and for the most part had less than 15 feet of clear length.

When clear-cutting upland hardwood pole stands, skilled cutters using hand tools produce 3 1/2 tons per man-day. The production in the uplands is lower because the wood is harder, the stocking is thinner, and the trees are limbier. Bottomland stands frequently originate on old fields where the young trees grow thick, straight, and tall. Upland timber stands that have been reduced by fire, grazing, and heavy cutting contain cull trees of all shapes and sizes. Cutting these into cordwood with hand tools is slow work.

7/ Campbell, Robert A., Pine pulpwood production. Tech. Note 66, Southeastern Forest Experiment Station, November 5, 1946. (Multilithed)

Cutting Logging Slash

Logging slash is not ordinarily cut into cordwood except under most favorable conditions, or where a land-clearing contract specifies slash removal. Working conditions in heavy slash are difficult and exasperating. If the work is not done soon after logging, the wood loses moisture and becomes harder and more difficult to process. At present prices, cutting slash is not very lucrative but may, under favorable conditions, yield good wages.

Heavy slash of bottomland species, especially cottonwood, offers a good opportunity for the axman. Four to five tons per man-day can be cut if the cutters are not required to remove all merchantable wood. This tonnage was equalled by men working in the slash resulting from logging a cottonwood overstory of 8 to 10 thousand board feet per acre. The presence of a sawlog-sized understory of soft maple did not seem to hinder the work. If all heavy material must be removed and the slash lopped and scattered or piled for burning, the average cut per man-day will probably drop to about 3 tons.

Clear-cutting oak-hickory saw-timber stands sometimes leaves enough volume in tops and limbs to justify a cutting for feltwood. This is especially true if only the large logs (16 inches and larger in diameter) are removed leaving heavy material in the tops. If extra men are available to chop and clear away the "brush," chain saws, particularly the one-man variety, can sometimes be used effectively. Three- and four-man chain-saw crews were able to cut 4 to 5 tons per man-day in oak slash where men with hand tools cut only 2 to 3 tons. Trucks were usually able to load feltwood at the stump, making skidding or draying unnecessary. It is doubtful if a partial or "selective" cut would leave enough accessible slash to justify a separate feltwood cut although logging and feltwood cutting might be profitably integrated.

Partial Cuttings

A question commonly asked is, "Can farmers or other woodlot owners make stand improvement cuttings and thinnings and sell the product for feltwood for enough to pay the cost of the cut?" To some extent this question remains unanswered because no actual instances of partial cuttings for feltwood on private lands were observed. However, some deductions can be drawn from clear-cuttings of poorly stocked stands and from partial cuttings on state and national forests.

As a general rule, feltwood does not pay the cost of improvement cuts unless high-value products are taken in the same operation. In an integrated logging job, some poor-quality trees might be marketed profitably as feltwood if the overhead cost were charged to sawlogs. "Wolf" trees, because of their size and difficulty in handling, seldom return the cost of their removal. There are, however, exceptions to the general rule. Some heavily stocked bottomland

stands contain certain "weed" species such as boxelder and sassafras that can be cut profitably for feltwood, leaving more growing space for cottonwood and soft maple. Profitable improvement cuts have been made in these stands when wood delivered at the chipper sold for as little as $3.25 a ton, the reason being that the trees were 8 to 12 inches in diameter and averaged 60 feet in height. Thirty tons or more per acre were removed. In the depleted upland woodlots, which are most in need of improvement cuts, the higher cost of operation usually makes these cuts unprofitable. On one operation where cull trees and blackjack oak were removed from a black oak stand, the loss on feltwood ran as high as $30 an acre. Only about 10 tons per acre were cut.

The same statements that were made about improvement cuttings can be made of thinnings. In heavily stocked bottomland pole stands, it is quite possible to make a profitable partial cut, but in the upland stands, thinning for feltwood is much more likely to result in a loss than a profit. If posts and mine timbers are produced from the better species, the greater return for these items may help to pay for the removal of tops and poor species. The benefit to the stand in increased future growth may of course offset a current loss sustained in making either a thinning or an improvement cutting.

TRANSPORTATION

Truck vs. Rail

Cordwood in the Central States region is ordinarily transported by truck for short distances and by rail for longer hauls. Small- or medium-sized trucks are in most cases the most efficient transportation equipment. Truck hauls are usually less than 20 miles; rail hauls have been as long as 300 miles. Actually, rail shipments require more coordination and planning than can be expended on most cordwood enterprises. The small volumes of wood cut and the uncertainty of cutting operations make carloading difficult. Considerably more round feltwood is delivered by truck than by rail. Some trucking is done at a loss by truckers who fail to keep cost accounts and unknowingly haul beyond their economic range.

Truck Loading and Hauling

Truck loading is a job customarily performed by the truck driver and the cutters from whom he collects wood. Hand methods are commonly employed. At present, no mechanical means of loading have been used with much success. Occasionally a farmer may employ a makeshift device such as a manure loader to do the heavy lifting, but on small jobs this saves neither time nor money. Boom-loading, loading of "packaged" cordwood, end-loading with winches, and other refinements have not made their appearance in feltwood operations. The average time for loading under favorable circumstances is about one-half man-hour per ton, with 3-man crews probably being the most efficient.

Small volume per acre, rough terrain, and other adverse factors can increase this average time. Unloading by hand in the woodyard takes 10 to 15 man-minutes per ton for a 2-man crew (fig. 3).

Figure 3.--Unloading cordwood from trucks in a storage yard.

The 1 1/2-ton trucks in common use carry loads of 4 to 5 tons. Contract hauling costs usually total about one-third of the delivered price of the wood. Consequently, the trucker receives $5.50 to $9.00 for a 5-ton load. Many truckers, using old vehicles and operating over poor-quality roads, cannot average 5 tons per load. They must then make three trips a day in order to earn wages and pay expenses on their equipment. Thus their maximum distance for economical trucking is 20 to 25 miles--the distance over which they can make three round trips a day.

Farmers and loggers bringing in feltwood sometimes employ larger, more powerful trucks than those of the woodcutters and contract haulers. Costs for operation of these vehicles were not studied, because their use for feltwood was only incidental to other uses. Cost of operation of 1 1/2-ton trucks used primarily for feltwood hauling is estimated in the appendix, pages 30-31.

Rail Loading and Hauling

The small-town railroad sidings in wooded sections serve as good feltwood-collecting points. Large trucks or truck-trailer combinations might compete for this hauling business, but a regular schedule would be difficult to maintain. Large trucks cannot be taken into the woods without special roads, therefore, their use would involve draying to a central point and reloading the same as in rail shipments.

Five main items of cost to the shipper of wood must be considered under a system of rail shipment. They are:

1. Hauling to the siding
2. Loading on cars

3. Freight charges
4. Demurrage
5. Weight of wood

The cost of hauling to the siding with 1 1/2-ton trucks is treated above and in appendix pages 30-31.

The time required for hand-loading of railroad cars is, of course, affected by many variable factors. For loading 6-foot wood, 4 to 10 inches in diameter, a reasonable average for 3-man crews is one-third man-hour per ton. This is the time spent moving wood from the bed of a truck over the side of an open coal car and laying it flat in the car (fig. 4). The labor required to transfer wood from a railside stockpile to coal cars, using 1 1/2-ton trucks and 3-man crews, is about 1 man-hour per ton. Contract truckers have been charging $1.25 to $1.40 a ton for this work, which includes truck loading, hauling, and loading the cordwood into cars.

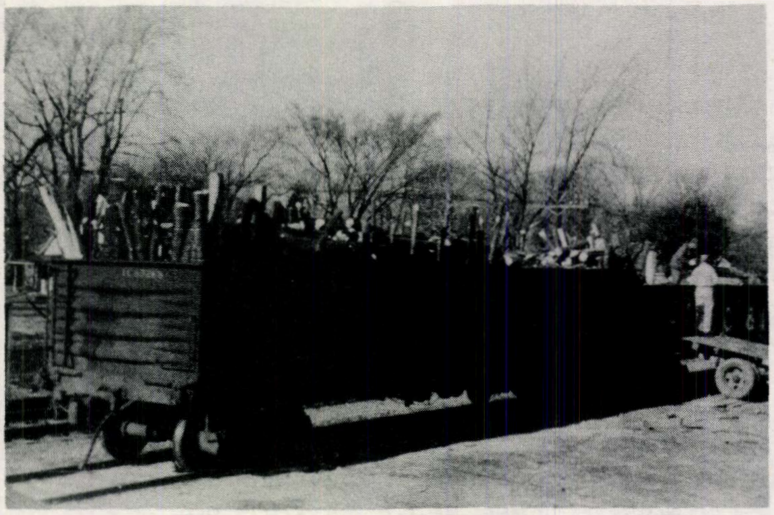

Figure 4.--Truckers loading cordwood into open coal cars.

Freight rates likewise vary among different railroads. Different rates may be charged for pulpwood, feltwood, and fuelwood, shipped equal distances on the same road. When it is necessary to switch a shipment from one road to another en route, the cost is usually greater than shipping an equal distance over one road. The only way to make sure of the rate is to consult the local agent or other railroad official. One carrier quotes the following rates on cordwood, which in this case has been construed to include feltwood.

Miles	Carload rate per ton (2,000 lbs.)
30	$1.12
40	1.20
60	1.38
80	1.55
100	1.72
120	1.87

These rates include all increases granted by Interstate Commerce Commission through August 15, 1948, but do not include the federal tax of 3 percent, which must also be paid by the shipper.

These are "distance commodity" rates for shipments in intrastate traffic only. Interstate rates are higher. Carriers that have no established distance commodity rates may charge higher rates for both intrastate and interstate traffic. Finally, there are "commodity" rates which may be set up if the volume of business from any one point or to any one point justifies special treatment. Commodity rates are negotiated for each particular set of circumstances and are usually lower than the rates quoted above.

Demurrage rates are the same everywhere. The shipper is allowed 48 hours after the first 7:00 a.m. following the spotting of the car. Demurrage charges begin the third day and are assessed as follows:

Days on siding	Demurrage (as of January 1948)	Cumulative total
3rd	$3.30	$3.30
4th	3.30	6.60
5th	5.50	12.10
each day thereafter	5.50	---

Spotting an empty car and removing it empty during the first two days because of lack of wood or to save subsequent demurrage charges costs the shipper $3.30.

The open coal cars used for feltwood hauling are of different sizes--those most commonly used being of 40, 50, and 70 tons capacity. When cars are loaded with wood, rather than coal, these maximum weights are never reached. Shippers of wood are more concerned with loading the minimum weight. Regardless of car size, the usual minimum weight, for which the shipper must pay, is 20 tons.

If cars are loaded with green wood to the height of their sides, little trouble is encountered in loading the minimum weight, but carloads of partially air-dried wood may weigh less than 20 tons. Loads of green bottomland hardwoods average 20 to 24 tons per car. When stakes are set around the top and wood is piled higher than the sides, carloads may weigh 30 tons or more. Substitution of oak, hickory, and other heavy species will increase these weights substantially.

CHIPPING

Chipping Plant Location

The problem of where to locate the chipper--near the woods or at the mill--depends on the mill's rail connections, its distance from a source of wood, and the wage rates in different localities. Felt mills

located in predominately urban and agricultural areas must import most of their wood from distant points. These mills ordinarily pay a low price for wood but have a high transportation charge. Other mills, located in areas where wood is available, secure the greater part of their supply from local cuttings. These latter mills usually pay a higher price to the cutter and trucker, who in turn frequently pay a nominal stumpage price to the landowner.

Chipping near the woods has several advantages. Frequently more space is available to store wood. Wood can be accumulated in favorable working weather and used when bad weather prevents cutting or hauling. Wage rates in wooded rural localities are usually lower, as is the cost of living. Wood chipped near its source and shipped by rail is easily loaded and unloaded mechanically once it is in chip form, thus saving a large part of the cost of rail shipment.

Advantages of locating a chipper at the felt mill includes: (1) the possibility of utilizing some local wood without rail shipment charges, (2) possible savings in cost of power, (3) better maintenance facilities, and (4) the opportunity to assign other work to chipper attendants when the chipper is not running.

Equipment Needed

The principal items required to set up a chipping plant at either mill or railside are:

1. Physical site, including space for wood storage
2. Building to house the machinery
3. Truck, dray, or conveyor to carry wood from yard to chipper
4. Chipper
5. Blower, belt, or other chip conveyor (not always required)
6. Power unit

Theoretically the wood storage yard need not be larger than is necessary to hold a 3-months supply. If one-half of the wood received is fed directly to the chipper and one-half is piled in the yard, the stored wood can be "turned over" every 6 months. Hardwood that is more than 6 months old is likely to be too dry for efficient fiberizing. In actual practice, however, seasonal changes in wood delivery may make desirable either a larger or smaller wood inventory.

The function of the chipper house is to protect the chipper, power unit, and blower from the weather, and in some cases to provide a tool and grinding room. A simple frame building is satisfactory although more elaborate structures are used. An unloading platform should be built at the feed spout of the chipper, unless wood is to be carried by a conveyor system.

Wood can be moved from yard to chipper by several means, none of which is completely satisfactory. Old trucks and trailers may be

cheap to operate but require much labor to load and unload. Conveyors, or "drags" must be extensive or the cost of bringing wood to the conveyor may equal that of bringing it direct to the chipper. Stackers and cranes, as used in large pulp mills, are too expensive for small chipping plants. Perhaps the most promising arrangement is a hydraulic forklift mounted on the front of a tractor (fig. 5). The forks can be lowered so that the lower pair is pushed under a pile of wood as the tractor is driven forward. Hydraulic power raises the forks aloft, lifting about one-third cord of wood. With the load in this "up" position, the tractor is driven to the chipper unloading platform, where the load is deposited on inclined rails. Bolts slide down the rails into position to be pushed manually into the chipper throat.

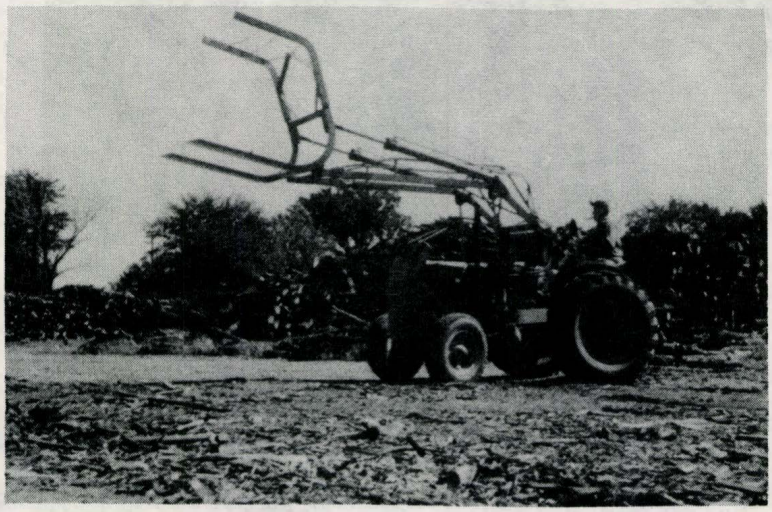

Figure 5.--Hydraulic forklift mounted on a rubber-tired tractor.

For the most part chippers now used in the felt industry were originally designed to process peeled pulpwood (fig. 6). They usually have four knives supported on rotating wheels 54 to 88 inches in diameter. Although they do a good job on rough bolts of bottomland hardwoods, they are not wholly satisfactory for chipping large oak and hickory bolts, veneer cores, or slabs. New designs are needed and are being supplied by manufacturers as demand develops.

A chip blower or conveyor is necessary when chips must be moved more than a few feet. When the receiving vehicles are parked directly next to the chipper, these aids can be eliminated. If metal fins are attached to the chipper wheel, enough force will be generated to carry the chips up a spout to a height of about 15 feet. Railroad cars can be loaded with this arrangement. Ordinarily open coal cars, with or without drop bottoms, are used to carry chips (fig. 7).

Electric motors used to drive roundwood chippers range from 75 to 200 horsepower, depending on the size of the chipper and the maximum diameter of the bolts. A chipper that will handle 12-inch pieces requires at least 150 horsepower; if such pieces are handled in volume, 200 horsepower is better. Small chippers, admitting bolts no larger than 6 inches in diameter may be adequately powered with 75

or 100 horsepower motors. Gasoline or Diesel engines may be used, but electric motors, which can tolerate short overloads, are preferable.

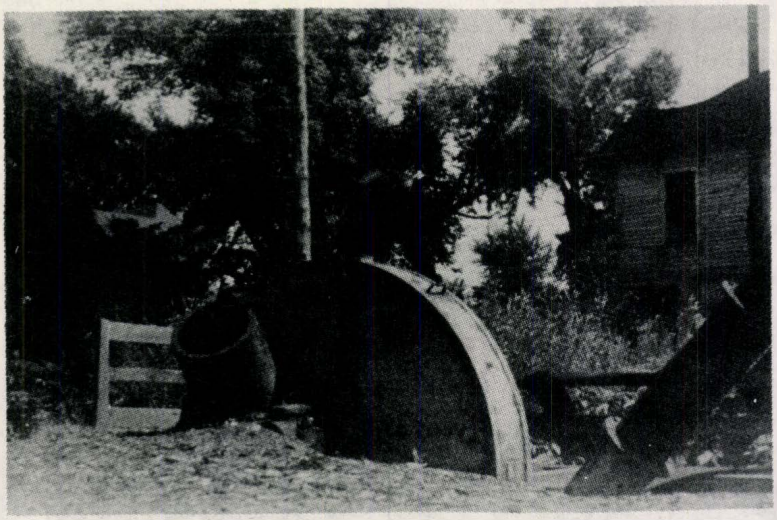

Figure 6.--Chipper located in the open at a rail siding. Input throat is at the left, output spout is the diagonally ascending pipe.

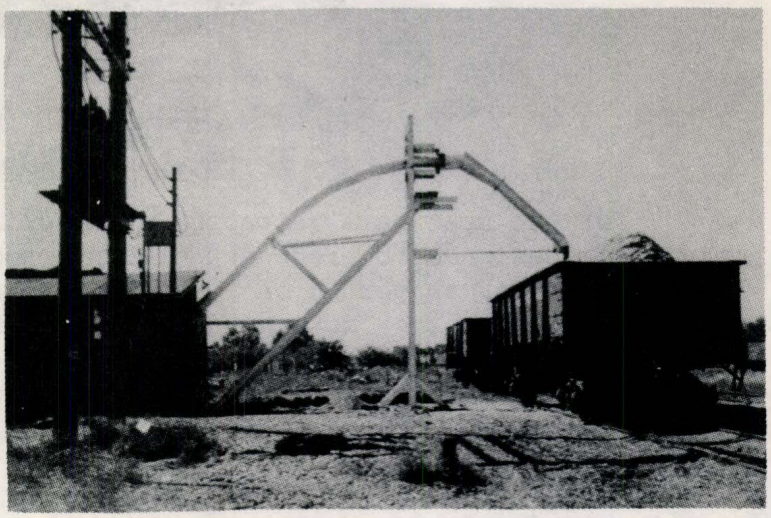

Figure 7.--Railside chipping plant, showing chips being blown into coal cars.

Typical Costs

Listed below are sample costs of operating a small plant chipping wood for shipment by rail. Costs are based on these assumptions:

1. Plant has contracted to deliver 1200 tons of chips per month.
2. Mill accepts chips of both upland and bottomland species.
3. Foreman supervises entire operation including contacts with wood suppliers and railroad. He also keeps records and does some manual labor.

	Costs per month
Rent on land	$ 50.00
Building and miscellaneous equipment (initial cost $1,000)	
Depreciation (120-month basis)	8.33
Interest (6 percent of average annual investment)	2.75
Tractor-loader (initial cost $2600)	
Depreciation (96 month-basis)	27.08
Interest (6 percent of average annual investment)	7.31
Operating expenses	50.00
Chipper (initial cost $5500)	
Depreciation (120-month basis)	45.83
Interest (6 percent of average annual investment)	15.13
Knives ($80 per set, life 4 months)	20.00
Grinding knives	35.00
Other maintenance	20.00
Motor (electric, 200 hp., initial cost $2,000)	
Depreciation (120-month basis)	16.67
Interest (6 percent of average annual investment)	5.50
Blower (initial cost $2,000)	
Depreciation (120-month basis)	16.67
Interest (6 percent of average annual investment)	5.50
Power (2¢ per kw.-hr., 50¢ per hp. minimum)	140.00
Labor	
Foreman @ $1.70 per hour	272.00
4 laborers @ 85¢ per hour	544.00
Payroll tax @ 8 percent	65.28
Weighing charges @ 10¢ per truckload	26.70
Total	$1373.75 8/

$1373.75 ÷ 1200 = $1.14 per ton

8/ Charges should also be made for overhead, insurance, and working capital.

Theoretically this cost per ton could be reduced. The organization outlined above could, if no delays in production occurred, fulfill its weekly quota of approximately 300 tons in four working days. But delays are inevitable. Some of them are caused by local conditions such as bad weather, machinery breakdowns, scarcity of empty cars, and lack of wood. Others result from temporary losses of market. Wood requirements change, and since the storage space at most mills is limited, the changes are felt almost immediately at the chipping plant. Because speeding up or slowing down chip production, due to changing mill requirements, causes loss of efficiency at the chipping plant, costs go up. Under actual operating conditions, chipping costs vary from $1.00 to $1.50 or more per ton.

Rail Transportation of Chips

The minimum shipping weight for carloads of chips is the same as that for carloads of roundwood: 20 tons. Coal cars will hold as much as 25 tons of green hardwood chips, but carloads of partially air-dried chips--especially chips from bottomland species--may weigh no more than 15 tons. Of course the same quantity of fiber is delivered whether the chips are green or dry, but if buying and selling is on a weight basis, moisture content is important. Special "commodity" freight rates for chips are usually negotiated when chipping plants are established.

SAWMILL AND OTHER MANUFACTURING WASTE

Although round cordwood has been the largest source of fiberized wood for roofing felt, a secondary source has been the byproducts of sawmills and other wood-using industries. Makers of other coarse fiber products should also weigh the possibilities, costs, and results of using mill waste. The U. S. Forest Service estimates[9] that 1944 production of slabs, edgings, and trimmings from the 10,000 Central States sawmills was 42 million cubic feet, or more than one million tons of green wood. Of this, 60 percent was used for fuel, and 40 percent was not used at all. Here is 400,000 tons of material per year waiting to be put to some profitable use, and 600,000 tons that might be put to a more profitable use. Much of it is offered at a price that is less than the labor cost of cutting an equal quantity of cordwood in the forest.

Coarse sawmill waste [10] has certain disadvantages when chipped and fiberized by present methods. It contains a high percentage of bark--as much as 50 percent by volume--which contributes little fiber strength. When fed through an ordinary roundwood chipper, quantities of large pieces and fine slivers, rather than uniform chips, are produced. Furthermore, sawed material dries quickly and cannot be stockpiled

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9/ U. S. Forest Service. Wood waste in the United States. Washington 1947. (Multilithed, 45 pp.)

10/ Includes slabs, edgings, and trims but not shavings or sawdust.

as long as roundwood. For these reasons central hardwood slabs are not used by the felt industry, although slabwood chips are included in shipments from northern Wisconsin. The Wisconsin chips are acceptable for one or more of the following reasons:

1. Part of the wood comes from veneer cores and cull veneer, which of course is bark free.

2. Some of the wood is hemlock or other conifers, which have longer fibers with better felting properties.

3. Some of the wood comes from slabs of debarked logs, which are bark free.

Some changes in present equipment design or, in some cases, entirely new types of equipment are needed to make more acceptable chips from the slabs and edgings of hardwood logs. Special chippers are needed to make uniform chips from this material. Inexpensive debarking devices are necessary to process slabs and edgings. Most barkers now in use are designed to do a complete job of bark removal, but felt mills and other producers of rough paper and board can tolerate a certain amount of bark. If 75 percent of the bark on slabs were removed, the wood-bark ratio of the slabs would be approximately that of round feltwood. A cheap slab barker of the friction or chain type might be a permanent installation at some mills. A slab barker operated with a chipper at a concentration point is another possible arrangement.

Some experimental work has been done on the separation of bark from wood after chipping. Separating machinery is used extensively with agricultural commodities, segregating fruit from hulls, viable seed from infertile seed, and large pieces from small pieces. If similar machinery can cheaply separate wood chips from loose bark, several kinds of wood that are now too expensive to debark may be used. Costs and results of using this equipment on Central States hardwoods are not yet known.

THE LARGER SAWMILLS

No sawmills in this region consistently cut as much as 40 thousand board feet of lumber per day. At the end of 1945, only six mills were cutting an average of 20 thousand board feet per working day. The waste in slabs and edgings, including bark, is about 1 ton per thousand board feet of lumber sawed, but resawing and remanufacturing of low-grade boards and purchased lumber may in some cases double the available refuse. Although there are approximately 10,000 active sawmills in the region, probably no more than a dozen are large enough to provide more than 20 tons--one carload--of coarse waste per day.

How shall a sawmill operator know if he can install a chipper and sell slabwood chips to advantage? The answer depends upon the

value of his wood for other uses, the costs of chipping wood, the cost of transporting chips, and the selling price of chips. The operator will have to determine most of these facts through his own private investigation, but information obtained in this study may provide a starting point.

Economic uses for slabs are few, even at the larger mills. Small pieces like tent stakes, tie plugs, and turning squares are sometimes cut from slabwood; ordinarily most of it is used for fuel or is not used at all. Any operator who keeps cost accounts knows the value of his wood for small products. Fuel values can be roughly calculated by comparing the heat values of wood with those of other fuels on a weight-cost basis as follows. If coal costs $10 a ton delivered, and 2 tons of dry mixed hardwood equals one ton of coal in heat value, dry wood is worth $5 a ton as fuel. But 40 percent of the weight of mill refuse is water; therefore, green wood is worth $3 a ton as fuel. This calculation does not include the cost of hogging and conveying the waste, nor does it consider the cost of conversion to an alternate fuel. It is, however, an indication of the value of slabwood used as fuel, a value that chips must exceed if they are to be made from potential fuelwood. Likewise, the sale of chips must produce more income than the sale of slabs and edgings for local fuelwood.

A sawmill shipping chips by rail should have an output of at least one carload--20 to 25 tons--per day, to make the chipping operation worthwhile. A lower output would probably cause some cars to be held long enough to incur demurrage charges. Conceivably, chips could be trucked short distances to a consumer, but with most of the larger sawmills far from industrial centers, truck hauls are only a future possibility. Thus, to have a chipper, a mill should either cut at least 20 thousand board feet a day or supplement with resaw refuse, purchased slabs, or roundwood.

A sawmill chipping 20 to 50 tons of refuse a day should be able to produce chips for less than $1 per ton, if power costs are reasonable and the wood is handled mechanically throughout the process. Conservative estimates of the costs of power, maintenance, depreciation, and labor are shown below:

	Output: 50 tons per day Cost per ton	Output: 25 tons per day Cost per ton
Power	$0.20	$0.30
Maintenance	.10	.10
Depreciation	.10	.15
Labor	.35 (2 men)	.35 (1 man)
Total	$ .75	$ .90

The chipper should be large enough to accommodate all but the largest slabs. A few wide slabs can be split by the tail sawyer, but if an extra man must be hired to split or rip slabs, the cost per ton will, in the long run, exceed the added cost of operating a larger chipper.

Chippers capable of handling slabs up to 17 inches in width can be powered by a 100-horsepower motor. This power requirement is considerably less than that needed to chip large pieces of roundwood. As a matter of fact, starting the chipper imposes a greater load on the motor than any volume of slabs likely to reach the machine in rapid sequence.

The smaller the volume of output, the greater is the need for mechanization. If the operation is well-mechanized, only one man--a chipper attendant--may be necessary. Waste can be mechanically conveyed from saw to chipper, and chips conveyed or blown to waiting vehicles.

The selling price of chips produced from coarse sawmill waste is unpredictable except that it ordinarily could not exceed the price of chips produced from roundwood. A small volume of chips from slabs of upland hardwoods is being produced and marketed now, but the chips are used in metallurgical processes, not for pulp. This special market is at present so limited that the price is not significant. At those mills where waste disposal is a problem, oak-hickory chips might be offered at cost if markets were available.

SMALL SAWMILLS

The operator of a small or portable mill frequently has no outlet for slabs and edgings other than at a give-away price for fuelwood. In the Central States region many of the small sawmills are located where oil, gas, or coal is produced locally and is relatively cheap. In these localities wood, to the homeowner, is often "the most expensive thing you can burn." Hence, slab piles are left to rot in the woods (fig. 8). In the tabulation below is a sample of the range of prices paid for slabwood, taken from random observations in 1948. These prices are on a "come and get it" basis. They are high near cities where fireplace wood is in demand, and are low in rural, forested areas, especially where other fuels are abundant.

Location	Price per cord
Sandusky, Ohio	$9.00
Norwalk, Ohio	7.50
Columbus, Ohio	6.00
Effingham, Illinois	4.25
Dale, Indiana	2.80
Murphysboro, Illinois	2.00
Albion, Illinois	1.00
MacArthur, Ohio	1.00

The concentrating and handling of slabs and edgings is the chief problem in the economical production of chips from the coarse waste of small sawmills. The best method that has yet been proven in actual practice is to install a chipper at a rail siding where a number of small mills are within easy trucking distance. Slabs and edgings can

be collected periodically so that mills are kept free of coarse refuse and the chipper is kept in nearly continuous operation.

Figure 8.--Portable sawmill and its waste pile. Note thick slabs and cull boards.

The following example illustrates methods and costs involved in collecting and chipping coarse waste from small sawmills. A chipper operator has a market for 60 tons (approximately 2 1/2 to 3 carloads) of chips a day, requiring the slabs and edgings resulting from a daily cut of 40 to 60 thousand board feet of lumber from logs of the sizes commonly cut in this region. He contracts for this quantity of slabs and edgings with mills located within a 30-mile radius of his chipper. He has three 1 1/2-ton trucks with winches and several removable racks that can be winched on to the truck bed when fully loaded. Empty racks are placed at sawmills in positions convenient to the offbearers, who load them with slabs and edgings. Trucks call for the loaded racks, leaving empty racks in their places. Preloading of the truck racks makes it possible for each truck to average four trips a day. If an average load of 5 tons per trip is hauled, the 60 tons required daily can be obtained.

A conservative estimate of the costs of this operation is as follows:

	Cost per ton
Wood at $2.00 per cord	$1.33
Trucking ($.13 a mile truck operation, $8.00 a day wages, 8 percent payroll taxes)	1.42
Chipping (1 attendant)	.75
Total for chips loaded in cars	$3.50

A chipper operator concentrating and chipping slabs and edgings would probably need a minimum of 40 to 60 tons of wood per day in order to make efficient use of his machinery. Suitable chipper locations--where this volume is available within short trucking distances--are limited to a few general areas. Southeastern Missouri, southeastern

Kentucky, and eastern and southern Ohio offer the best possibilities. A few borderline locations are in western Kentucky and southern Indiana (fig. 9). Estimating conservatively a coarse waste of one ton per thousand board feet of lumber sawed, each of the counties heavily shaded in figure 9 produces enough slabwood to operate a chipper. Of course, some of this volume has a present use, such as fuelwood. Additional wood could be drawn from the lightly shaded counties if mills were within truck-hauling distance. The chipper would have to be located on a railroad unless there were a local market for chips.

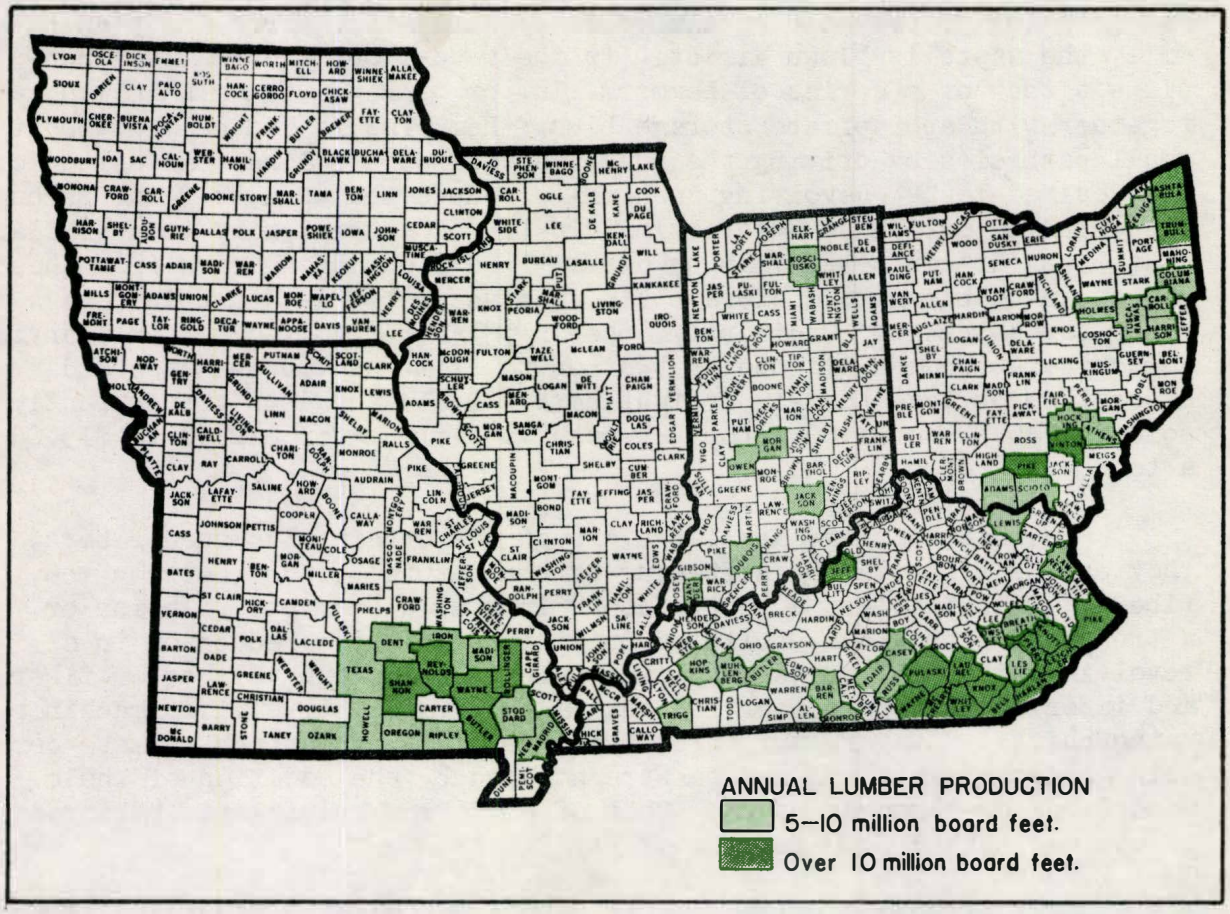


Figure 9.--Counties producing more than 5 million board feet of lumber annually. Based on 1942 Census (the latest complete coverage), revised where possible with more recent data.

Other primary industries such as stave and heading mills and handle plants produce waste in some of these counties. These mills could provide some of the supplementary wood needed during midwinter and harvest time when sawmills often have seasonal shutdowns. Even with this added supply, a chipper operator who depended on numerous small mills might find it necessary to carry an inventory of roundwood.

REMANUFACTURING PLANTS

The secondary wood-using plants such as planing mills, sash and door plants, flooring mills, and furniture factories are also a potential source of raw material for wood fiber. Wood obtained from these sources is usually dry, free from bark, and reduced to sawdust, shavings, and trims. It can either be ground mechanically to small particles or fiberized with the aid of steam or chemicals.

Sawdust and shavings can be ground to a coarse flour which adds bulk and absorbency to a product without adding much tensile strength. The grinding process can be almost fully automatic. From the planing mill, the waste is blown directly to the wood-flour plant. This consists either of a series of hammermills, or of revolving disk mills, together with appropriate storage bins. Hammermills reduce the wood to small particles by driving the shavings against a cylindrical screen of the desired mesh. Revolving disk mills reduce the wood to flour through the grinding action of a revolving disk in close proximity to a similar stationary or counter-revolving disk. Wood flour discharged from these mills can be blown to a storage bin from whence it is drawn into bags ready for shipment. Ordinarily, the only labor involved, other than for a machine attendant, is one or two men to fill and tie the bags and store them or load them in freight cars. Baled shavings are currently sold for $5.00 to $8.00 a ton, 20-mesh wood flour for $12.00 to $15.00 a ton.

Because shavings are large enough to contain undamaged fibers, they can be fiberized by softening of the natural binder between the fibers. This involves a short "cook" in a mild chemical solution or a treatment with steam, followed in either case by a reduction in a revolving disc mill. The resulting pulp is said to have shorter fibers and inferior felting properties than a pulp made with similar machinery using chips. However, pulp from shavings is strong enough to make certain grades of felt and can be strengthened by the addition of whole wood fiber or stronger pulps. Cost of pulp from shavings is believed to be less than $20.00 per ton of dry fiber.

Dry softwood rippings and trimmings can also be fiberized if they are first mechanically broken to approximately the same dimensions as chips, or small enough to pass a 2-inch mesh screen. The use of this type of raw material is a very recent development in manufacturing roofing felt. Early results indicate that this material produces a desirable fiber at a reasonable fiberizing cost. Furthermore, it is cheap and has, in some cases, a low milling-in-transit freight rate. Current prices of wood are about $10 a ton; moisture content is about 7 percent. Prices of this wood in terms of dry fiber delivered are comparable to prices for green chips, the moisture content of which is usually greater than 40 percent of total weight. The locations and available volume of this wood and the cost of concentrating it and processing it to chip size are not generally known. It may become an important source of raw material for coarse fiber.

The grinding of sawdust and shavings to wood flour and the pulping of shavings and blockwood have been successful with softwoods. Volume is divided between southern yellow, western white, and Ponderosa pines, Douglasfir, and a few minor western species. Mill operators have found that any use of hardwood necessitates changes in operating procedure and usually results in increased costs, caused by lower production rates and higher machinery maintenance charges.

SUMMARY AND CONCLUSIONS

In the Central States region, there is a tremendous volume of unused wood in low-quality standing trees, logging waste, manufacturing and remanufacturing waste. Much of this volume is suitable for the production of coarse fiber. The demand for products that can be made from coarse fiber is currently increasing. In meeting this demand, manufacturers will use the raw material that yields an acceptable product at the lowest total cost. Wood, which is cheaper than most fibers, will probably continue to be used in increasingly larger quantities.

Roundwood has a relatively small proportion of bark and, by present methods, is technically superior for the production of coarse fiber. At present, land clearing provides roundwood at the lowest cost. Little or nothing is paid for stumpage obtained in clear-cutting even the best pole-timber stands, and in some cases a premium is paid for removing the timber. Green roundwood will be supplied from this source until landowners refuse to sell. Before this happens, owners must be convinced of the wisdom of holding young timber for future growth, foregoing present payments for greater future returns. If forest management is not only accepted but practiced, cheap pole stumpage may become scarce.

Because the present prices of roundwood scarcely exceed the costs of clear-cutting and hauling, partial cuts seldom pay their way except under optimum conditions. In easily accessible pole stands located near the market, thinnings can be made at a profit. Improvement cuttings of undesirable trees nearly always cost more than is obtained by selling the wood removed. Some logging slash can be salvaged at a profit, especially if the wood-cutting operation is integrated with logging, and if a nearby market is available. In general, the return is somewhat less than from clear-cutting, and working conditions are less desirable.

Coarse sawmill waste is the cheapest and one of the most abundant sources of wood for coarse fiber. It is partly concentrated. On the other hand, it is the costliest and least satisfactory to fiberize. Special equipment is needed for barking, chipping, and other processing before much coarse sawmill waste will be used for fiber.

Broken blockwood from remanufacturing plants is easy to process, yields a desirable fiber, and may be the cheapest source of wood for mills located near wood-working centers. Current prices per ton of

dry wood are comparable to prices for green chips. The volume of this wood, long a drug on the market, may be insufficient to supply the future demand.

Table 1 below summarizes the current average prices of fiber materials discussed in the text.

Table 1.--Prices of wood, rags, and waste paper f.o.b. car 1/

Item	Approximate moisture content (wet basis)	Prices per ton as shipped (wet basis)	Equivalent prices per dry ton
	Percent	Dollars	Dollars
Chips from sawmill waste	40	2.50 - 4.50	4.15 - 7.50
Chips from roundwood	40	4.50 - 6.85	7.50 - 11.40
Dry shavings from planing mills	7	5.00 - 8.00	5.40 - 8.60
Dry blockwood from planing mills	7	9.00 - 10.00	9.70 - 10.75
Wood flour, 20 mesh	7	11.00 - 15.00	11.85 - 16.15
Whole wood fiber (shredded aspen)	40	15.00 - 16.00	25.00 - 26.65
Waste paper	--	12.00 - 15.00	--
Roofing rags	--	25.00 - 40.00	--

1/ Prices per ton as shipped are market prices with the exception of item 2, which is the market price of cordwood plus $1.25 average chipping cost. Equivalent prices per dry ton compensate for the moisture content of each item.

APPENDIX

ESTIMATED TRUCK-OPERATING COSTS FOR CORD-WOOD HAULING IN THE CENTRAL STATES REGION

Although hauling distance and road conditions determine to a large extent whether a particular cutting chance will show a profit or a loss, the costs of operating trucks hauling cordwood under differing conditions are not generally known. Truckers and timber operators need a simple system for estimating truck operating costs to aid in keeping books on current operations and to make realistic appraisals of future cutting chances. Farmers can use such a system to determine the feasibility of marketing the products of thinnings and improvement cuttings in farmwoods, where the margin of profit is likely to be very slender.

11/

The tabulation on the following pages can be used without adjustment to make rough estimates of hauling costs. Cost items are based on the operation of a new 1 1/2-ton truck in the Central States region at 1947 prices. For greater accuracy, the tabulation should be checked for agreement with current on-the-ground prices before being applied to a particular operation. Local variations in wage rates, etc., will make differences that will require adjustment.

In making this tabulation, we assume that the truck is new, that it will be used for cordwood hauling 225 days a year, and that it will be traded in for another new one after 300 working days. Actually, many truckers are using prewar vehicles and many of them do other kinds of hauling part of the time. However, it is probable that the costs of repair and maintenance (labor, materials, and lost working time) on old trucks are so large and variable that averages would not be very useful.

When an operator has adjusted Part I of the tabulation to fit his particular circumstances, he has a rather accurate estimate of his fixed expenses per day. By multiplying his driving distances (payload plus return trip) over each type of road by the factors given in Part II, he can estimate his running expenses per round trip. This figure multiplied by the average number of trips per day and added to fixed expenses equals truck-operating costs per day.

11/ Adapted from Reynolds, R. R. Pulpwood and log production costs as affected by type of road. Occ. Paper No. 96, Southern Forest Experiment Station, New Orleans, 1940.

Part I

Investment	Dollars
Truck, long wheelbase, dual wheels	1550.00
Minus tires (6 at $60) 12/	360.00
Net investment	1190.00
Minus trade-in-value, truck	200.00
Amount to be depreciated	990.00

Fixed expenses (annual basis)

Interest on investment at 6 percent 13/	63.98
License (5-ton average load)	75.00
Operating overhead and insurance	60.00
Total fixed expenses per year	198.98

	Owner driving own truck	Owner hiring truck driver
Above expenses on a daily basis (225 working days per year)	$ 0.88	$ 0.88
Depreciation of truck per day (life 300 working days)	3.30	3.30
Driver's wages at $8 per day 14/	8.00	8.00
Payroll tax (8 percent of labor cost)	--	.64
Total fixed expenses per day	$12.18	$12.82

Part II

Running expenses per mile (woods or low-quality road)

Tires (life 8,000 miles)	0.045
Gasoline (5 miles per gallon)	.045
Oil and grease ($3.00 every 800 miles)	.004
Repair and maintenance	.006
Total	0.100

12/ Cost of tires charged against running expenses.

13/ Average investment - $\frac{\text{initial investment + trade-in value}}{2} + \frac{\text{annual depreciation}}{2} - \frac{\$1190 + \$200}{2} + \frac{\$742.50}{2} = \$1066.25$

14/ It is assumed that an owner driving his own truck will include his own wages as a cost.

Part II (cont'd) Dollars

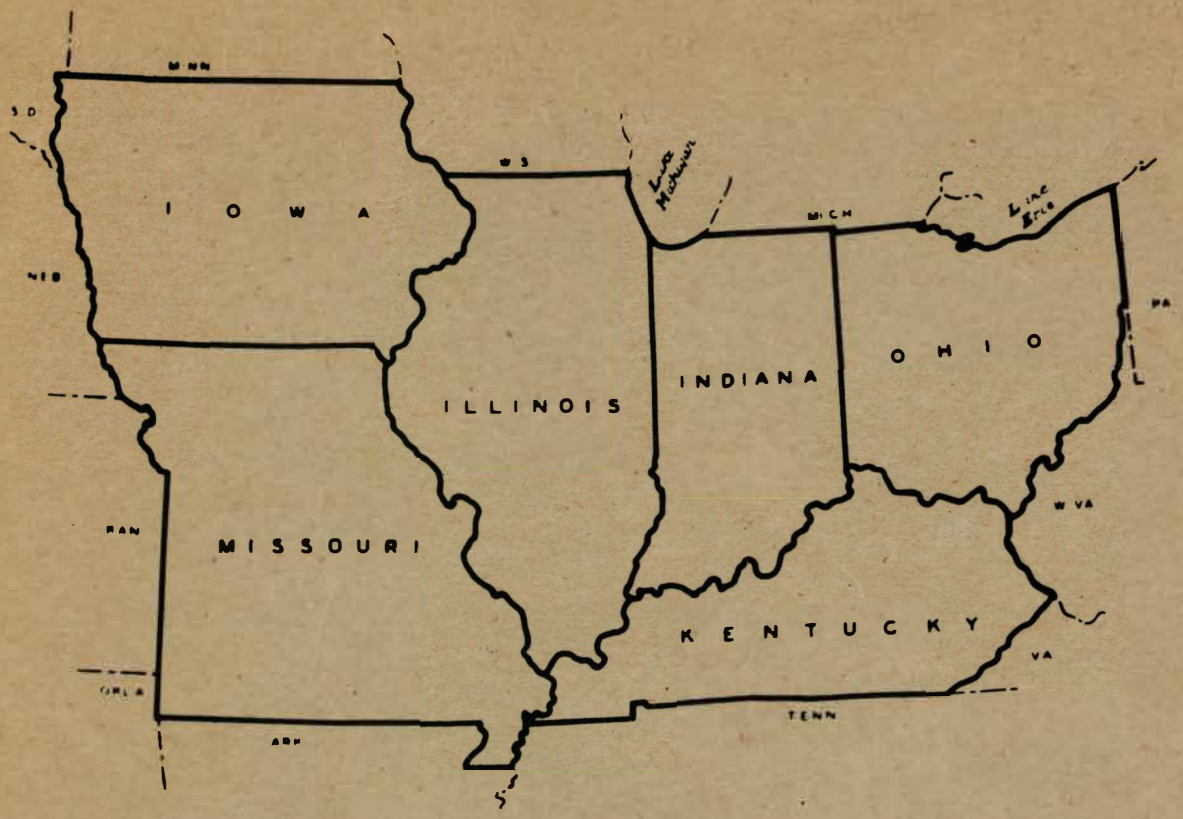
Running expenses per mile (graded or hard-surface road)

Tires (life 15,000 miles)	0.024
Gasoline (9 miles per gallon)	.026
Oil and grease ($3.00 every 800 miles)	.004
Repair and maintenance	.006
Total	0.060

Example

A trucker makes three round trips a day with an average load of 5 tons. His route from woods to mill includes 5 miles of woods road and 15 miles of paved highway. His costs can be estimated as follows:

Fixed expenses (taken from table)	$12.18 per day
Running expenses	
Woods road (10¢ x 6 trips x 5 miles)	3.00 per day
Paved road (6¢ x 6 trips x 15 miles)	5.40 per day
Total cost (including $8.00 wages to himself)	$20.58 per day
Total cost per ton ($20.58 ÷ 15 tons)	$1.37



TERRITORY SERVED

BY THE

CENTRAL STATES FOREST EXPERIMENT STATION

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